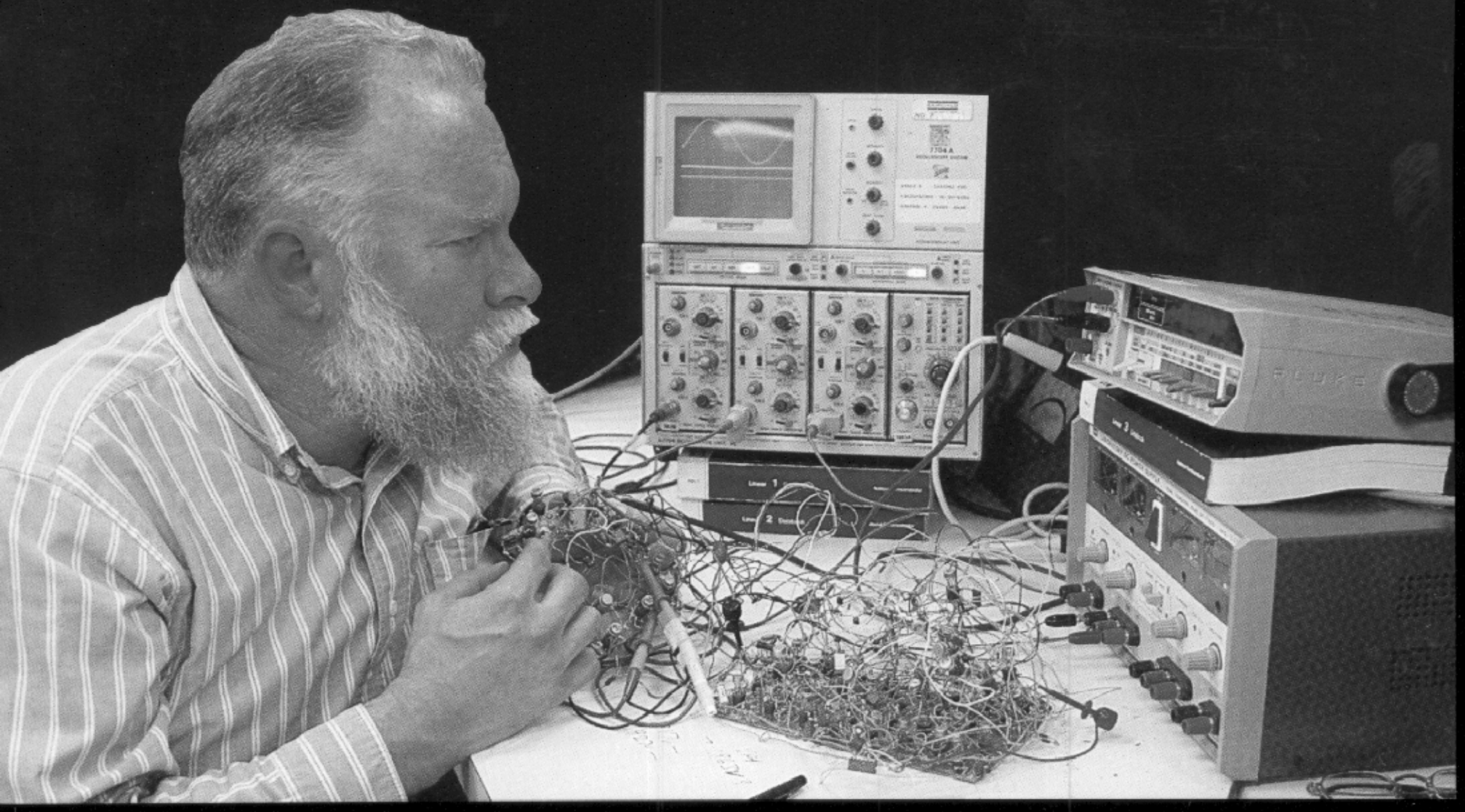
ROBERT A. PEASE

Troubleshooting Analog Circuits

National Semiconductor

EDN SERIES FOR DESIGN ENGINEERS



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Foreword

"Your idea is so good that, if you give me 20 minutes, I'll be sure that I was the first one to think of it." Although I pass out that accolade sparingly, if I were to do what the compliment implies, I'd surely claim credit for the idea of publishing Bob Pease's series on "Troubleshooting Analog Circuits" in *EDN* Magazine Edition. The fact is, though, that the idea came from Jon Titus, VP, Editorial Director, and Chief Editor of *EDN* magazine and from Tarlton Fleming, then an *EDN* Associate Editor and now Manager of Applications Engineering at Maxim Integrated Products Corporation.

In early 1988, Jon and those *EDN* technical editors who work at the publication's (and Cahners Publishing Company's) Newton, Massachusetts, headquarters were brainstorming ideas for articles we could solicit from contributors in industry. Jon ventured that because *EDN* readers always look to the magazine to provide practical ideas on how to do their jobs better, and because trouble is ubiquitous, articles on how to troubleshoot more effectively should be a natural for us.

Tarlton, who edited *EDN*'s popular Design Ideas section, worked with Bob on a regular basis, as Bob reviews the analog design ideas submitted by *EDN* readers. Tarlton recalled Bob's mentioning a book he and his colleagues at National Semiconductor were planning to write on power-supply design. Tarlton said he thought Bob had already put together some material on troubleshooting. We needed to find out whether National would grant *EDN* the rights to publish a portion of the book. Tarlton would open the discussions.

Shortly afterward, a good-sized package arrived at *EDN*'s offices. In it was the text of what would eventually become the first three installments of Bob's series. By then, Tarlton had left the East Coast to seek fame and fortune in Silicon Valley, so the task of reviewing Bob's material fell to me. I skimmed through it quickly and became quite intrigued.

I am a contemporary of Bob's; actually, I am a few years older. Though we did not know each other at the time, I was a graduate student in EE at MIT while Bob was an undergraduate there. I first became aware of Bob when he was working for his previous employer, George A. Philbrick Researches, now a part of Teledyne Components in Dedham, Massachusetts. Even in those days—the sixties and early seventies—Bob was a prolific writer. He shared his musings and technical insights with Philbrick customers and other analog engineers who read the firm's house organ, "The Lightning Empiricist," and with readers of trade magazines, such as *EDN*.

Those earlier writings did a lot to burnish Bob's image as a technical expert, but they had a secondary effect as well: They made his sense of humor and his passion for puns something of a legend. As a form of humor, plays on words are denigrated by all too many people. However, at least a few openly admit to enjoying puns, and that group includes Bob and myself. Many years ago, when I first read material Bob had written, I suspected that if I ever met him, I'd probably like him. When I started to read what he had just submitted to *EDN*, the experience was a bit like a chance encounter with an old friend after not meeting up with him for a long time.

The material was somewhat out of the ordinary for *EDN*. It was technical, yes . . . but it was lighter than most of what we publish. There were few equations and no

complex schematics. Would the readers like it? My guess was they would; the manuscript was filled with pithy and trenchant observations.

The style was different too. In the past, rigid constraints forced articles into a homogenized mold—albeit one that, despite the magazine's highly technical content, was almost always eminently clear and readable. Now we're a bit more relaxed. We still rewrite extensively for clarity, but we try to let a writer's style and personality show through. I think part of the reason for our change in attitude was the success of Bob's series.

Bob's style not only displays his sense of humor, it showcases his idiosyncratic and sometimes quirky nature. Most of all, however, his perfectionism and consummate craftsmanship are clearly evident. I pointed out that if we tried to force what Bob had given us into a more traditional mold, it would lose a significant part of its value. Among the reasons that Bob is so successful are who he is and how he approaches problems. There was no better way than through his style to convey the essence of Bob's personality to the readers.

One of *EDN*'s "rules" is that we don't use rhetorical questions; readers may answer them in unexpected ways—ways that can play havoc with the point the writer is trying to make. The staff jokes that we "ration" rhetorical questions. According to the legend, each issue, our managing editor, Joan Morrow Lynch, grants one editor who requests it the right to ask a rhetorical question. She does so on a first-come, first-served basis, but can only deny the privilege to anyone whose recent work has posed too many of the queries. After reading what eventually became the first installment of "Troubleshooting Analog Circuits," I observed that this one article would more than use up *EDN*'s entire annual allotment of rhetorical questions. "But, why not risk it?" I asked; Bob begins solving problems by asking questions.

Something about the series that, to my knowledge, is unique is that it approaches the subject of troubleshooting from a design engineer's perspective. *EDN* readers are designers. Pease is an accomplished designer. Yet he is one who not only doesn't see troubleshooting as beneath his exalted station, he views the activity as part and parcel of his job. Indeed, he revels in it, and his writing effectively communicates his passion for exorcising the hobgoblins that bedevil electronic circuits.

That fact was not wasted on the readers. Their reaction was overwhelmingly positive. Never in the magazine's history (almost 35 years) has something that *EDN* published evoked such an enthusiastic outpouring. Every few weeks, a new deck of reader-service cards circulates around our offices. There are the cards on which readers have written comments—in addition to making requests for more information on products advertised and mentioned in the magazine. The decks for the issues that contained the series installments invariably contained scores of hand-written notes asserting that Bob's articles were marvelous; the best that *EDN* had ever printed. In fact, *EDN's* readers voted all 12 articles the best-read contributed manuscripts in their respective issues. Once the series ended, we started getting cards that asked for the articles in book form. First, the book requests were a trickle, but they rapidly swelled to a torrent. So, for all of you who asked for it and for those who never saw the series in *EDN* but who have decried the lack of a compendium on troubleshooting from a designer's perspective, here it is.

Lest it appear that I was the sole *EDN* staff member who edited Bob's work, let me make it clear that I wasn't even the one who did the most editing. In addition to myself, the technical editors were Senior Editor Charles H. Small, and Anne Watson Swager, now *EDN*'s East-Coast regional Editor in Wynnewood, Pennsylvania. The nontechnical editing of every article in the series was done by Associate Editor Julie Anne Schofield. *EDN*'s Art Department, directed by Ken Racicot, handled the

graphic work in Newton. In addition, many of the photos were taken by Bob's colleagues at National Semiconductor. Despite its length, this list of contributors isn't complete. A magazine is the work of many people, and any list inevitably omits someone.

What should be apparent from the above is that working on the series was fun! When he first interviewed me for this job at *EDN*, Roy Forsberg, now publisher of another Cahners magazine, *Test and Measurement World,* remarked that a technical editor's job was the best job in all of electronics. At the time, I passed off Roy's comment as somewhat self-serving. But working on the Pease series dispelled any doubt I might have had about how much fun the job can be. Working on the series was a great experience! As important as Bob's tips on troubleshooting are, I hope the series—and now the book—provide more; I hope they communicate the exhilaration felt by all of us who were involved with the project.

Dan Strassberg
Associate Editor
EDN Magazine

Don't Understand Analog Troubleshooting? Relax. Bob Pease Does.

"Fools you are . . . to say you learn by your experience. . . . I prefer to profit by others' mistakes and avoid the price of my own."

—Otto von Bismarck, 19th Century Prussian Chancellor

Bob Pease is one of the legends of analog design. Over the years, he's developed techniques and methods to expedite the often-difficult tasks of debugging and troubleshooting analog circuits. Now, Bob has compiled his "battle-tested" methods in the pages of this book. Based on his immensely popular series in *EDN Magazine,* the book contains a wealth of new material. Every chapter has been expanded, and two new chapters and several useful appendices have been added. Numerous tables summarizing troubleshooting approaches for various components are another welcome addition.

Whether you are primarily an analog or digital engineer/technician, experienced or neophyte, this book has something for you. You'll find Bob's approach to problem identification and isolation to be applicable to a wide spectrum of engineering disciplines. Bob will be your personal mentor in these pages, giving you an intuitive grasp of where problems are likely to show up and how to positively identify them. The book includes:

- advice on using simple equipment to troubleshoot (would you believe an ordinary AM radio?)
- plenty of step-by-step procedures that "walk you through" analog troubleshooting methods
- generous helpings of Bob's unique insights, humor, and philosophy regarding analog circuits

Bob believes that technical books don't have to be dry to be informative, and we think you'll agree with him. Armed with his clear explanations and proven techniques, you'll be prepared to get your analog designs "up and running" for the ever-increasing tasks demanded of today's electronic devices.

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